REPRODUCTION OF THE HOUSE MOUSE, *MUS MUSCULUS* L., IN THE CHRISTCHURCH AREA

R.N. GIBSON,

Department of Zoology, University of Canterbury,
Christchurch, New Zealand.

ABSTRACT

Some population characteristics of the mouse, *Mus musculus*, collected by fumigation and trapping from suburban and pastoral areas and grain stores near Christchurch from 6 March to 18 July 1970 are described. Significantly more females (83) than males (59) were caught ($P < 0.05$); female predominance was greater in samples of heavier (> 16.5 g) and older (> 20 weeks) mice.

Both sexes became fecund at about 8 weeks old and 10.6 - 12.5 g body weight. An index of testis size (length and width) was correlated with fecundity in both laboratory and wild male mice, although values differed. Corpora lutea in the ovaries of females indicated fecundity. A significantly greater ($P < 0.02$) proportion of females heavier than 18.5 g were pregnant (71%) than was so in lighter females (21%). There was no increase in average proportion pregnant with increasing age. On average, 36% of females were fecund during the collection period and each produced 3.34 litters (total 19.2 embryos) in that time. Extrapolating from the sex ratio in 31 nestling mice (19 females; 12 males) 11.8 of the embryos would become daughters.

Apart from the above, some of the main conclusions of this study are that the visibility of tubules in the cauda epididymis is the best indicator of male fecundity; the presence of corpora lutea in the ovaries indicates female fecundity; the breeding of wild mice in Christchurch may continue into the winter, the physical condition of females, as indicated by their weight, is more important than age in affecting fertility.

INTRODUCTION

The common house mouse, *Mus musculus* L., is the only mouse species in New Zealand. It was accidentally introduced into New Zealand, probably in the early 19th Century, being first recorded on Ruapuke Island in Foveaux Strait following a ship-wreck there in 1824 (McNab 1907). The spread of house mice through New Zealand closely paralleled that of European occupation and the species is now found throughout New Zealand. The biology of the house mouse in New Zealand is poorly known. Wodzicki (1950) reported that they occupy a wide range of habitats and notes on their control, identification and distribution have been recorded (McIntosh and Adams 1955, Watson 1959, Wodzicki 1963), but there is little other published work.

Mus musculus has a world-wide distribution and has been much studied because of its importance to agriculture, food storage and medical science. There have been numerous studies of the dynamics of natural populations (Delong 1967, Newsome 1969a, Pearson 1963), particularly on those subject to dramatic changes in size, but rarely on apparently stable populations. Pastoral and corn rick populations have been studied in Australia (Newsome 1969b) and in the United Kingdom (Berry 1968, Rowe, Raylor and Chudley 1963, 1964, Southern and Laurie 1946, Southwick 1958) but only Laurie (1946) has studied house mouse populations from a range of habitats.

The aim of this study was to compare population characteristics of house mice from different habitats. Mouse populations in grain store, surburban and pastoral areas around Christchurch were sampled for this purpose.

METHODS

A variety of methods, including the use of fumigation (chloropicrin) and break-back traps were used to collect 142 mice between 6 March and 18 July 1970. All mice were weighed and measured and their reproductive condition assessed. Placental scars, vaginal perforations, visible corpora lutea, and embryo numbers and their distribution in the uterine horns were noted. The position (abdominal or scrotal), length and width of testes and whether tubules were visible through the wall of the cauda epididymis were recorded. As the extent of testis decomposition and dehydration varied, testes weights were not recorded. A laboratory population of 49 male mice was also examined and the same information was recorded.

The age in weeks of wild mice was calculated from equations based on head and body lengths of captive mice (Newsome 1969a). A 19.5 day average period of gestation (Laurie 1946) and a 14.5 day period of visible pregnancy (Snell 1941) were used in the analysis of pregnancy data.

RESULTS

SAMPLE CHARACTERISTICS

Significantly more females than males were caught (83 : 59, $p < 0.05$). Female predominance was greatest in mice heavier than 16.5 g and in those aged more than 20 weeks. A higher proportion of mice heavier than 12.5 g were taken by break-back traps than by other means, and all age classes excluding nestlings were well represented in trapped samples.

FECUNDITY

Males and females from all habitats became fecund at 10.6-12.5 g at an age of about 8 weeks. The product of testis length and width showed a high correlation (0.93 Spearman Rho rank correlation) with fresh testis weights in the laboratory mice. The constancy of testis weight increase with the size index allowed fecundity assessment by either criterion once the level at which sperm production occurred was determined. The distinction between fecund and non-fecund mice using the size index, was equally clear in the wild and laboratory samples. Forty-nine of 50 wild mice reached fecundity at a testis size index of 16.3 mm^2 which was, however, about half the value for laboratory mice.

In 20% of the male mice assessment of fecundity based on testes position differed from the other fecundity criteria. Mice with corpora lutea in the ovary had a 10 mm minimum uterus horn width while mice without corpora lutea all had less than 12 mm uterus horn width. Ten mice without corpora lutea had perforated vaginae. In several others determination of vaginal condition was not possible because of damage to the specimens.

FERTILITY

A body-weight of 18.5 g (Table 1) and an age of 30 weeks (Table 2) were used to divide the sample into two classes of comparable numbers for pregnancy comparisons. The two weight classes had significantly different pregnancy rates ($p < 0.020$) and modified pregnancy rates ($p < 0.025$). These rates were not significantly different, however, between age classes.

To allow for differences in the weight composition of samples standardised percentages (Laurie 1966) were used to compare autumn and winter samples (Table 3). The percentage pregnant in each period was not significantly different.

PRODUCTIVITY

An average proportion of 0.36 fecund females were pregnant during the period 6 March to 18 July 1970. Use of 14.5 days as the period of gestation during which pregnancy was visible (Emlen and Davis 1948) gives a collection period productivity of 3.34 litters, or one litter every 40 days. If mice with uterine scars are included productivity is 5.10 litters, or one litter every 26 days. Although nothing is published on the period during which the sites of embryo implantation, or embryo scars, remain visible, these can be used as evidence of recent pregnancy owing to the relatively short period between oestrus cycles and

TABLE 1. DISTRIBUTION OF PREGNANCIES WITH BODY WEIGHT

Body weight	N	Pregnancies	% pregnant
10.6 - 18.5 g	33	7 (13)	21 (40)
18.6 - 26.5 g	14	10 (13)	71 (93)

TABLE 2. DISTRIBUTION OF PREGNANCIES WITH AGE

Ascribed age	N	Pregnancies	% pregnant
< 30 weeks	32	13 (18)	38 (56)
> 30 weeks	15	5 (8)	33 (53)

TABLE 3. PREGNANCY RATE WITH TIME

Period	Percent pregnant	Standardized percent pregnant
Autumn (6 March- 25 April 1970)	39 (61)	36 (54)
Winter (26 April- 20 August 1970)	21 (43)	27 (51)

The numbers in parentheses in Tables 1, 2 and 3 include mice showing uterine scars which, if accepted as evidence of recent pregnancy, provide a modified pregnancy rate.

the uterine wall reconstruction which then occurs. The 3.24 litters multiplied by the average number of embryos per pregnant female gives an embryo production of 19.2 per fecund female for the period.

Of 31 nestling mice, 19 were females. If this sex ratio is representative of the nestling population then the number of daughters produced per fecund female during the period, estimated by multiplying the embryo productivity by 19/31 is 11.8 for the period. In species such as *Mus musculus*, where one male may mate with more than one female, the productivity of daughters has greater relevance than overall production of young in determining recruitment.

Several workers have recorded foetal elimination in house mice but Laurie (1946), using the same method of embryo counting as used here, found that by deducting 3% for resorption, the embryo counts were approximately equivalent to fertility rates. A further 3% reduction for undetected resorption gives a corrected value for those expected to be born. In five of the pregnant mice eight embryos were considerably smaller than the others in the same uteri. Four of these (in one uterus) were decomposed and therefore not considered, leaving four embryos which were small and possibly degenerate from a total of 87 embryos.

DISCUSSION AND CONCLUSIONS

FECUNDITY

Laurie (1946) found that in food-store mouse populations 95% of females were fecund at 10 g body-weight. In this study a comparable percentage occurred at about 12.5 g showing that female mice reach fecundity at a heavier weight in the Christchurch area than in the United Kingdom. Southwick (1955) and Crowcroft and Lowe (1957) have evaluated fecundity criteria and concluded that testes position and vaginal condition were reliable measures for freshly killed laboratory mice. Howard (1950), Jameson (1950), Laurie (1946) and Southern and Laurie (1946) have all stressed the unreliability of these measures when working with collected carcasses. Personal observations suggest that partial testis retraction occurs as a "fright" reaction and Howard (1950) cites cases of testes being raised and lowered in various species of *Peromyscus*, including migration of testes when carcasses were frozen and warmed. Newsome (1969a) noted that considerably fewer sperm were produced from adult mice with abdominal testes. Several of the fecund mice in the latter part of the collection had abdominal testes. The appraisal of fecundity criteria in this study supports the use of visibility of tubules in the cauda epididymis and of corpora lutea in the ovary to determine fecundity in males and females respectively when dealing with large numbers of mice.

FERTILITY

The constancy of pregnancy rate during the collection period (Table 3) suggests that breeding may continue into winter.

Laurie (1946) found no significant seasonal differences in breeding in the United Kingdom but Rowe et al (1964) showed seasonal variations in corn-rick populations.

The productivity value of one litter per 26 days, obtained when uterine scars are included as evidence of pregnancies, is within the theoretical maximum if the usual average delay in implantation for post-partum fertilization is accepted. The wide range of collection methods makes it unlikely that pregnant mice were selectively taken and it is probable that during the collection period (6 March - 20 June) mice in the Christchurch area were making maximum use of the resources in each habitat by producing litters at close to their greatest potential rate.

The number of embryos produced over the collection period suggests an annual production of 50.4 embryos per fecund female. Although no evidence was obtained to support this extrapolation to a whole year, the relative constancy in breeding rates found in the United Kingdom and Russia (Laurie 1946) suggests that embryo production may be of this magnitude in some habitats. The large seasonal differences reported by Lidicker (1966) in California, Newsome (1969a, 1969b) in Australia and Rowe et al (1964) in the United Kingdom have been in corn-rick and pastoral populations. Although no differences occurred in mice from pastoral sources in this study samples were too small to provide conclusive evidence.

The significantly higher pregnancy rate in heavier (Table 1) rather than older (Table 2) fecund mice, suggests that the physical condition of the female is the prime determinant of fertility.

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